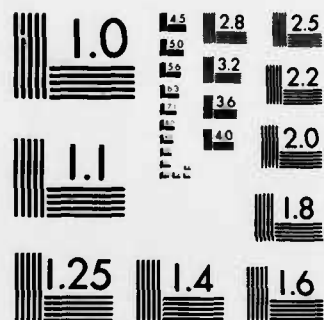


AD-A036 890 NAVAL INTELLIGENCE SUPPORT CENTER WASHINGTON D C TRA--ETC F/6 8/14  
TOWED H-MAGNETOMETER (BUKSIRUYEMYY H-MAGNITOMETR), (U)  
FEB 77 I G ZHURIY , A Y ROTSHEYN  
UNCLASSIFIED NISC-TRANS-3900 NL

| OF |  
AD  
A03689D



END  
DATE  
FILMED  
4-77



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



DEPARTMENT OF THE NAVY  
NAVAL INTELLIGENCE SUPPORT CENTER  
TRANSLATION DIVISION  
4301 SUITLAND ROAD  
WASHINGTON, D.C. 20390

(3) 78

ADA 036890

(10) I.G. Zhuriy A.Ya. Rotshteyn

CLASSIFICATION: UNCLASSIFIED

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

TITLE:

(6) Towed H-Magnetometer  
(Buksiruyemyy H-Magnitometr)

(11) 1 Feb 77

(12) 6p.

AUTHOR(S): Zhuriy, I.G., Rotshteyn, A.Ya.

PAGES:

5 (2) Trans 8

SOURCE:

Geofizicheskaya Apparatura N49 1972  
p13-16 1972

(14) NISC-Trans-3900

(USSR)

ORIGINAL LANGUAGE: Russian

TRANSLATOR: C

NISC TRANSLATION NO. 3900 ✓

APPROVED P.T.K.

DATE 1 February 1977

DDC  
RECEIVED  
MAR 15 1977  
A

COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

407282

4/B

# TOWED H-MAGNETOMETER

[Zhuriy, I. G. and A. Ya. Rotshteyn, Buksiruyemyy H-Magnitometr, Geofizicheskaya Apparatura, No. 49, 1972, pp. 13-16; Russian]

Measurements of the TMF on a water surface are made with magnetometers placed in a towed "bird" behind the ship. Towed component magnetometers are currently in the design and testing stage.<sup>3,7</sup> In the present paper, the authors propose a magnetometer for direct measurement of the horizontal component of the TMF with indirect stabilization of the MFE of the quantum magnetometer (with a rigid mounting of the MFE in the towed "bird").

As is well known,<sup>9</sup> to measure the horizontal component of the TMF with a quantum magnetometer, it is necessary to generate a vertical auxiliary compensating field (ACF) in the Helmholtz coils (HC). If the HC and MFE are mounted on a moving object, the auxiliary field is generated by the summation of the fields of each of the three pairs of orthogonal HC whose magnetic axes are parallel to the axes of the vertical gyroscope (Fig. 1). The field strengths in each pair of HC are determined by the angles of roll  $\theta$  and pitch  $\psi$  of the "bird." The angles of deflection of the object from the vertical are measured with the vertical gyroscope. The currents in the coils are calculated from the formulas given by A. Ya. Rotshteyn and I. G. Zhuriy,<sup>5,6</sup>

$$\left. \begin{aligned} I_I &= U_0 k_I \cos \psi \cos \theta; \\ I_{II} &= U_0 k_{II} \sin \psi; \\ I_{III} &= U_0 k_{III} \cos \psi \sin \theta, \end{aligned} \right\} \quad (1)$$

where  $U_0$  is the supply voltage, and  $k_I$ ,  $k_{II}$ , and  $k_{III}$  are the transmission coefficients of the computing system, consisting of two sine-cosine rotary transformers (SCRT), located on the vertical gyroscope.

To generate an auxiliary field  $H_a$  equal in magnitude to the vertical component of the TMF for displacements of the towed "bird" in the latitudinal direction, it is necessary to regulate the ACF either manually or by means of an automatic compensation system.<sup>4,8</sup> A modulating field according to expression (1) must be created in the volume of the gauge for the operation of the automatic compensation system.

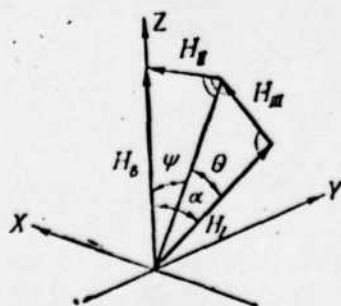


Fig. 1. Summation of vectors of HC magnetic fields

\* Numbers in the right margin indicate pagination in the original text.

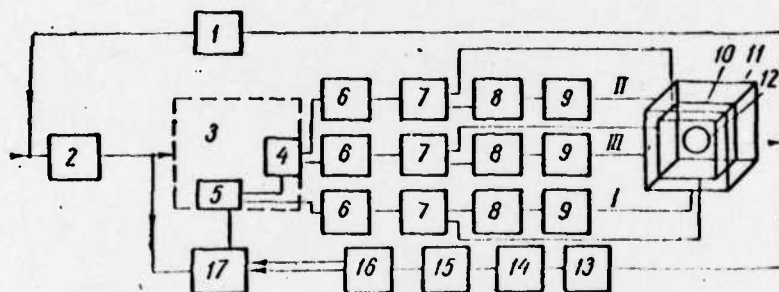


Fig. 2. Block diagram of towed II-magnetometer

To measure the horizontal component, a magnetometer was designed, a block diagram of which is shown in Fig. 2. The instrument consists of systems for generating the ACF and automatic compensation, and of a modular magnetometer /14 itself. The supply from converter 2 is fed to vertical gyroscope 3 and a computing system consisting of two SCRT, 4 and 5. From the computing system, the signals are sent to the corresponding HC 11 via scaling transformers 6, transformers 7, phase detectors 8 and smoothing filters 9. Since the modulating field must be vertical, its generation requires three pairs of extra windings on coils 10, in which the currents are calculated with the computing system by use of formulas (1). The ac signals are rectified with full-wave phase detector 8. The automatic compensation system consists of frequency detector 13, filter of the first harmonic 14, amplifier 15, and servo motor 16 for regulating  $U_0$ ;  $\Pi$  and  $T$  are measured with MFE 12; SCRT 17 is used for the adjustment of  $U_0$ . The signal from MFE 12 is fed to the towing ship via electronic block 1. The currents for each pair of coils are calculated from three channels: channel I converts the signals fed to the vertical coils, and channels II and III convert those fed to the horizontal coils.

ACCESSION for	
RTIC	White Section <input checked="" type="checkbox"/>
DDC	Buff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. and/or SPECIAL
A	

Let us calculate the error involved in the generation of the ACF.

In Fig. 1, angle  $\alpha$  is the angle of deflection of the vertical axis of the towed "bird" from the vertical

$$\alpha = \arccos \frac{H_I}{\sqrt{H_I^2 + H_{II}^2 + H_{III}^2}}. \quad (2)$$

The quantities  $H_I$ ,  $H_{II}$ , and  $H_{III}$  include the coefficients  $k_I$ ,  $k_{II}$ , and  $k_{III}$ , /15  
determined with the errors

$$\left. \begin{aligned} k_I &= k_1 k_3 k_4 n_{I1} f_{I1} A_I \frac{1}{R_{H I}}, \\ k_{II} &= k_1 k_3 k_2 n_{II1} f_{II1} A_{II} \frac{1}{R_{H II}}, \\ k_{III} &= k_1 k_3 k_5 k_6 n_{III1} f_{III1} A_{III} \frac{1}{R_{H III}}, \end{aligned} \right\} \quad (3)$$

where  $k_1$  is the transmission coefficient of the SCRT used to adjust the ACF of the automatic compensation system;  $k_2$ ,  $k_3$ ,  $k_4$ , and  $k_5$  are the transformation coefficients

of the scaling transformer in channel II (see Fig. 2), SCRT 3, SCRT 4 and scaling transformer in channel 3, respectively;  $n_I$ ,  $n_{II}$ , and  $n_{III}$  are the transformation coefficients of transformers 7;  $f_I$ ,  $f_{II}$ , and  $f_{III}$  are the transmission coefficients of the phase detectors;  $A_I$ ,  $A_{II}$ , and  $A_{III}$  are the constants of HC.

Using formulas (1)-(3), we find the mean square error of angle  $\alpha$  (Ref. 2)

$$\sigma_\alpha = \frac{\cos \psi \cos \theta}{\sqrt{1 - \cos^2 \psi \cos^2 \theta}} \sqrt{\left( \frac{1 - \cos^2 \psi \cos^2 \theta}{r_I + R_{HI}} \Delta r_I \right)^2 + \dots + \left( \frac{\sin^2 \psi}{r_{II} + R_{HII}} \Delta r_{II} \right)^2 + \left( \frac{\cos^2 \psi \sin^2 \theta}{r_{III} + R_{HIII}} \Delta r_{III} \right)^2 + \dots + (\tan \psi \cdot \Delta \psi)^2 + (\tan \theta \cdot \Delta \theta)^2}, \quad (4)$$

where  $r_I$ ,  $r_{II}$ , and  $r_{III}$  are the resistances of the triodes in the conducting state of channels I, II, III.

Substituting for SCRT of class A the mean square error  $\Delta \psi = \Delta \theta = 0.00007$  rad,  $r_I = r_{II} = r_{III} = 8$  ohm,  $\Delta r = 0.1$  ohm,  $k_2 = 0.53$  and  $k_5 = 0.98$ , we obtain  $\sigma_\alpha$  for different values of the angles of roll and pitch:

$\psi = \theta$ , deg	1	5	10	15
$\sigma_\alpha$ , min	0.24	0.27	0.35	0.44.

Preliminary tests of the magnetometer showed that when the coil system deflected from the vertical by  $10^\circ$ , the ACF deflected by an angle of about  $1'$ .

The chief advantage of the proposed magnetometer is the absence of mechanical loads on the gyrosystem; this makes it possible to use a quantum magnetometer and avoid increasing the dynamic errors of the vertical gyroscope, and allows the MFE to be located at any distance from the vertical gyroscope. By using the magnetometer, H may be measured directly with a rigidly mounted MFE in the towed "bird."

#### REFERENCES

/16

1. Anisimov, B. V., Transistor Modulators (Tranzistornyye modulyatory), "Energiya" Publishing House, Moscow-Leningrad, 1964.
2. Malikov, S. F. and N. I. Tyurin, Introduction to Metrology (Vvedeniye v metrologiyu) Standards Publishing House, Moscow, 1965.
3. Karnaushenko, N. M., A three-component marine magnetometer. Electromagnetic Phenomena in the Sea (Elektromagn. yavleniya v more), Vol. 40, Marine Hydrophysical Institute, 1968.
4. Rotshteyn, A. Ya. and G. V. Alekseyev, Continuous automatic measurements of magnetic components. Geophysical Instruments (Geofiz. apparatura), Issue 45. "Nedra" Publishing House, Leningrad, 1971.



5. Rotshteyn, A. Ya. and I. G. Zhuriy, Measurement of absolute values of geomagnetic components from moving platforms. Geomagnetizm i aeronomiya, Vol. 10, No. 5. "Nauka" Publishing House, Moscow, 1970.
6. Rotshteyn, A. Ya. and I. G. Zhuriy, A device for measuring the horizontal component of the terrestrial magnetic field. Author's Certificate No. 278140. Bulletin No. 25, 1970.
7. Rusanova, N. V., Two-component magnetometer for marine magnetic surveying. Geophysical Instruments (Geofiz. apparatura), Issue 30. "Nedra" Publishing House, Leningrad, 1966.
8. Khvostov, O. P. and V. A. Prishchepo, A method of measuring the components of a magnetic field. Author's Certificate No. 274409. Bulletin No. 21, 1970.
9. Yanovskiy, B. M., Terrestrial Magnetism (Zemnoy magnetizm), Vol. 2. Leningrad State University, 1963.